Analysis of Handoff Failures in Movement based Asynchronous Mobile Computing System

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ABSTRACT

Mobile Computing System is a distributed system where one of the processes is known as Mobile Node. The Mobile Computing System have some limitations such as Low Bandwidth of wireless network, lack of stable storage, mobility handling, disconnection of mobile nodes (MNs) and limited battery life., In this paper we have analyzed various handoff schemes / algorithms. As we know movement based scheme takes a checkpoint only after a threshold, when mobility handoffs has been exceeded. The main issue regarding wireless and mobile computing technology is handoff, because of limited coverage of mobile support station (MSS). When a mobile node (MN) moves from current MSS to another MSS, then it needs to perform a handoff. This results in data loss and communication interruption. Many researchers worked to minimize this problem but it still remains a matter of research. In this paper, we suggest that AODV protocol is among the effective solution of the handoff failures in movement based asynchronous mobile computing environment.

Index Terms

Handoff Failure, Movement Based Recovery, AODV, Handoff techniques, Mobile Computing.

Abbreviations

Mobile Node (MN), Mobile Host (MH), Mobile Support Station (MSS), Ad-hoc On-demand Distance Vector (AODV).

1. INTRODUCTION

The development of wireless terminals and mobility has facilitated the rapid growth of wireless communication and mobile computing. Today, wireless cellular systems have played an important role in telecommunication infrastructure. Mobility is one of the major issues in the performance characterization in mobile computing systems. Mobile Computing technology allows transmission of data via a computer without having to be connected to a fixed physical link. Mobile Computing addresses those applications and technical issues that arise when persons move within a specific region or travel between countries and continents. This proves to be the best solution to the biggest problem of business people on the move. Mobile Nodes (MNs) are increasingly becoming common in distributed systems due to their availability, cost, and mobile connectivity. An Mobile Node is a computer that may retain its connectivity with the rest of the distributed system through a wireless network while on move(Garg & Kumar[1]). Wireless and mobile computing systems are prone to failures. Due to various reasons mobile computing systems encounter failures caused by software, hardware, human error, or a combination of these factors ([Kirsal & et.al [2]). Failure of a system depends on the system's nature and it has different impacts on the system performance. In mobile computing systems, handoff failures cause the degradation of the system performance. The system may not support the active MNs efficiently. Hence, the system performance may degrade. In order to overcome this problem, availability and performance issues of these systems should be considered. Mobility is the most important feature of a mobile computing system. The process of switching data transmission or transferring an ongoing call from the current MSS to the new MSS is called handoff (or handover). Usually, continuous service is achieved by supporting handoff from one cell to another. Handoff is the process of changing the channel (frequency, timeslot, spreading code or combination of them) associated with the current connection while a call is in progress. Each handoff requires network resources to reroute the call to the new mobile support station (MSS). Handoff is often initiated either by crossing a cell boundary or by a deterioration in quality of the signal in the current channel. Handoff is divided into two broad categories— hard and soft handoffs. They are also characterized by "break before make" [3] and "make before break." In hard handoffs, current resources are released before new resources are used; in soft handoffs, both existing and new resources are used during the handoff process.([Alagu et.al, 2011,[4]).

2. HANDOFF SCENARIOS

There are different scenarios of handoff which are discussed here

- When the MN is moving away from the area covered by on MSS and entering into the area covered by another BS, then handover is needed to transfer the connection of MN form current MSS to other MSS before the MN moves out of the range of first MSS, to avoid call termination.
- When the traffic handling capacity of any MSS is exhausted then in order to accommodate more or new calls, loaded MSS by means of handoff transfers the ongoing or newly originated call to the neighboring MSS with overlapping coverage area.
- Also we mean of handoff in case of interference (in non-CDMA environment) on any channel by different MN from

different cells (MSS) using the same channel (but in different cells) then call is transferred to another channel in same cell or another cell, in order to avoid interference.

- In non-CDMA environment when an fast moving MN connected to umbrella type cell, slows sown or stops then in order to shift the call from umbrella type (in order to efficiently use the umbrella cell capacity) to macro or micro type (whichever is needed) cell handover is needed.(Also applicable in reverse case).
- In order to avoid or reduce interference due to "near-far" effect in CDMA networks, soft handoff is useful in such scenarios[5].

3. HANDOFF PROCESS

- **Scanning** When a mobile station is moving away from its current MSS, it initiates the handoff process when the received signal strength and the signal-to-noise-ratio have decreased significantly. The mobile node scans the channels which the new MSS uses. As per (Hye-Soo Kim et. all,2004[12]), 90% of the handoff delay comes from channel scanning.
- **Authentication** Authentication is necessary to associate the link with the new MSS. Authentication must either immediately proceed to association or must immediately follow a channel scan cycle. In pre-authentication schemes, the mobile node authenticates with the new MSS immediately after the scan cycle finishes.
- **Re-Association** Re-association is a process for transferring associations from old MSS to new one. Bikramjeet et.al[13]focussed on reducing the scanning delay by minimizing the total number of scans performed.

4. DIFFERENCE BETWEEN HARD AND SOFT HANDOFF

There are basically two differences between them in respect of resource allocation and technical requirements in mobile device: Hard handoff, source channel is released, then target channel is engaged. Connection to source is broken before it is made to the target —known as break-before-make. Hard handoff needs to be instantaneous. It is perceived as an event during the call; requires the least processing by the network providing service. In a soft handoff, source channel is retained and used in parallel with target channel in the target cell. The connection to the target is established before the connection to the source is broken – known as make-before-break. It is perceived as a state of the call, rather than a brief event. [5]. Other differences are described in the Table -1.

Table--1 Differences between hard handoff & soft Handoff

Hard Handoff	Soft Handoff
Hard handoff has an advantage i.e, Only one channel needs to be allocated per call.	whereas soft handoff uses two or more than two, minimum two channels have to be assigned
Mobile Node's hardware does not need to be capable of receiving two or more channels in parallel, which makes it cheaper and simpler.	Mobile Node's hardware must be capable of receiving two or more channels in parallel, which makes it expensive and difficult.
The handoff time in hard handoff is very small such that it is not perceptible to the user	Whereas handoff time in soft handoff can be larger in case of soft handover.
Hard handoff provide lesser connection reliability The reason to this is, in case of hard handoff other connection is established on the release of the current one so in case the targeted connection is failed the call is dropped	The connection reliability is much higher in soft handoff, the reason is source connection is not released up to the moment till the target connection is established so, the chances of call drops are minimal and only observed in case of interference or fading of the source channel, which is rare.
	As, in during soft handover single MSS uses several channels for the single call so, due to this the overall capacity of the network is decreased as single node is involving more than one channel which in turn cannot be made available for other MSS's for new call. Also, in soft handover the call rates are costlier as more than one channel are occupied for single call.

5. Hard handoff between the MN and MSSs

In a hard handoff, the link to the prior MSS is terminated before or as the user is transferred to the new cell's MSS; the MN is linked to no more than one MSS at any given time. Hard handoff is primarily used in FDMA (frequency division multiple access) and TDMA (time division multiple access), where different frequency ranges are used in adjacent channels in order to minimize channel interference. So when the MN moves from one MSS to another MSS, it becomes impossible for it to communicate with both MSSs (since different frequencies are used).

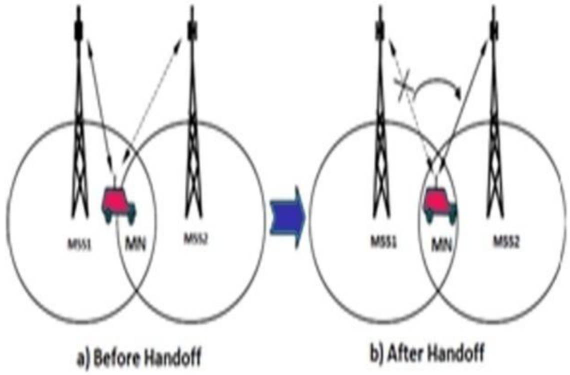

Figure - 1 Hard handoff

An MH communicates with the other nodes of the distributed system via a special node called mobile support station (MSS). A Mobile Computing System is a distributed system which consists of various distinct processes which are geographically separated and communicate with each other by exchanging messages[6]. In this system some processes are running on Mobile Node(MN) / Mobile Host(MH) that can move. We need to add Mobile Support Stations (MSSs) to communicate with mobile nodes (MNs). Mobile Support Stations (MSSs) communicate with each other through a wired network. The Mobile Node (MN) has some special properties, first it moves from one cell to another and hence, the handoff of MN must be properly and carefully handled[6][8]. Also, MN is connected to the MSS via a wireless network. As long as an MN is connected to an MSS, the channel between them also ensures FIFO communication in both the directions[7].

6. HANDOFF INITIATION

Handoff technique transfers an ongoing call from one cell to another as a user moves through the coverage area of a cellular system[4]. The handoff process is initiated by the issuing of handover request. The signal received by the mobile node from new MSS of neighboring cell exceeds the signal received from the MSS of the current cell by a certain amount [8]. This is a fixed value called the handover threshold. For successful handoff, a channel must be granted to handoff request before the signal received by the MN reaches the receiver's threshold. Each handoff requires network resources to reroute the call to the new MSS.

Hard handoff occurs when the connection to the old MSS is broken before a connection to the new MSS is activated. Its performance evaluation is based on various initiation criteria. The figure-2 shows that MN moves from MSS1 to MSS2. The mean signal strength of MSS1 decreases as the MN moves away from it. Similarly mean signal strength of MSS2 increases as the MN approaches it[4][9][10].

- **Relative Signal Strength**

This method selects the strongest received MSS at all times. The decision is based on a mean measurement of the received signal. In Figure-2 the handoff would occur at position X. This method is observed to provoke too many unnecessary handoffs, even when the signal of the current MSS is still at an acceptable level.

- **Relative Signal Strength with Threshold**

This method allows a MN to handover only if the current signal is sufficiently weak (less than threshold) and the other is the stronger of the two. The effect of the threshold depends on its relative value as compared to the signal strengths of the two MSSs at the point at which they are equal. If the threshold is higher than this value, say T1 as in Figure 2, this scheme performs exactly like the relative signal strength scheme, so the handoff occurs at position X. If the threshold is lower than this value, say T2 in Figure, the MN would delay handover until the current signal level crosses the threshold at position Y. In the case of T3, the delay may be so long that the MN drifts too far into the new cell. This reduces the quality of the communication link from MSS1 and may result in a dropped call. In addition, this results in additional interference to co-channel users. Thus, this scheme may create overlapping cell coverage areas. (See Figure-2)

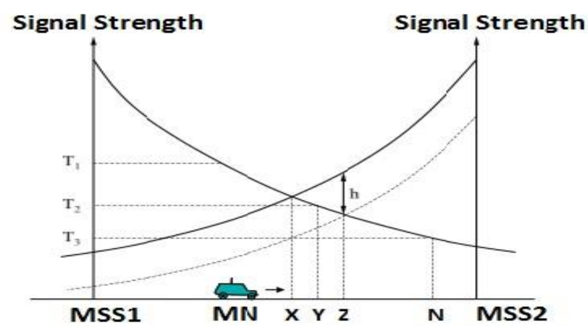

Figure-2 Signal strength and hysteresis between two adjacent BSs for potential handoff[9].

- **Relative Signal Strength with Hysteresis**

This scheme allows a user to handover only if the new MSS is sufficiently stronger (by a hysteresis margin, h than the current one. In this case, the handoff would occur at point Z. This technique prevents the so-called ping-pong effect, the repeated handoff between two BSs caused by rapid fluctuations in the received signal strengths from both MSSs. The first handoff, however, may be unnecessary if the serving MSS is sufficiently strong[26].

- **Relative Signal Strength with Hysteresis and Threshold**

This scheme hands a mobile node over to a new MSS only if the current signal level drops below a threshold and the target MSS is stronger than the current one by a given hysteresis margin. In Figure the handoff would occur at point N if the threshold is T3.

- **Prediction Techniques**

Prediction techniques base the handoff decision on the expected future value of the received signal strength. A technique has been proposed and simulated to indicate better results, in terms of reduction in the number of unnecessary handoffs, than the relative signal strength, both without and with hysteresis, and threshold methods.

7. HANDOFF TYPES

Handoffs may be classified based on some factors, such as the type of network, the involved network elements or the number of active connections and the type of traffic that the network supports. This classification is shown in Table 2. Firstly, handoffs can be distinguished into horizontal and vertical handoff, depending upon whether a handoff occurs between a single type of network interface or a variety of different network interfaces. With the penetration of the next generation networks, vertical handoffs are a common phenomenon. Horizontal handoffs in a cellular network can be broadly classified into intracell and intercell handoffs. Intracell hand- offs occur when a user, moving within a cell, changes radio channels in order to minimize interchannel interference under the same MSS. On the other hand, intercell handoffs occur when an MN moves into an adjacent cell and therefore, all the MNs connections should be transferred to the new MSS [14]. Vertical handoff is the process of changing the mobile active connection between different wireless technologies. Vertical handoffs can be further distinguished into Downward Vertical Handoff (DVH) and Upward Vertical Handoff (UVH).

In DVH the mobile user handoffs to the network that has higher bandwidth and limited coverage, while in UVH the mobile user transfers its connection to the network with lower bandwidth and wider coverage [15]. Handoffs can also be classified into hard and soft handoffs depending on which MSS is serving the MN in the crucial period during handoff execution when there is a communication between the user in question with more than one MSSs[A].

Table-2 Classification of Handoff types

Types	Classification	
Horizontal	**Intracell**	**Intercell**
	Soft	**Hard**
Vertical	**Downward**	**Upward**
	Soft	**Hard**

8. AD-HOC ON- DEMAND DISTANCE VECTOR ROUTING PROTOCOL (AODV)

It is reactive protocol which reduces the number of required broadcasts by creating routes on an on- demand basis. In reactive or on-demand protocols, a node initiates a route discovery throughout the network, only when it wants to send packets to its destination. for this purpose a node initiates a route discover process through the network. This process is completed once a route has been established, it is maintained by a route maintenance process until either the desired. The AODV protocol is one of more common routing algorithm in ad-hoc networks and is based on the principles of discover routes as needed. As we know AODV is reacting algorithm that has some capabilities such as low processing, memory overhead, low network utilization, and it works well even in high mobility situation. The request is made on demand rather than in advance, to count for the continually changing network structure, which is likely to invalidate routing tables over time [21]

AODV is composed of (1) Route Discover (2) Route Maintenace. It uses Route Request (RREQ), Route Reply (RREP) contro; messages in Route discovery phase and Route Error(RERR) control message in Route Maintenance phase. Detailed header information of control messages given in [22].

In general, the nodes participating in the communication can be classified as source node, an intermediate node or a destination node. When source node wants to connect to a destination node, first it checks in the existing routing table, as to whether a fresh route to that destination is available or not. If fresh enough route is available, it uses the same. Otherwise a node initiates a Route Discovery by broadcasting a PREQ control message to all of its neoghbours. This PREQ message will further be again broadcasted by the intermediate nodes to their neighbours. This process will continue until the destination node or an intermediate node having a fresh route to the destination. At this stage eventually RREP control message is generated. Thus a source node after sending a RREQ waits for RREPs to be received. Figure-3 shows traversal of control messages.

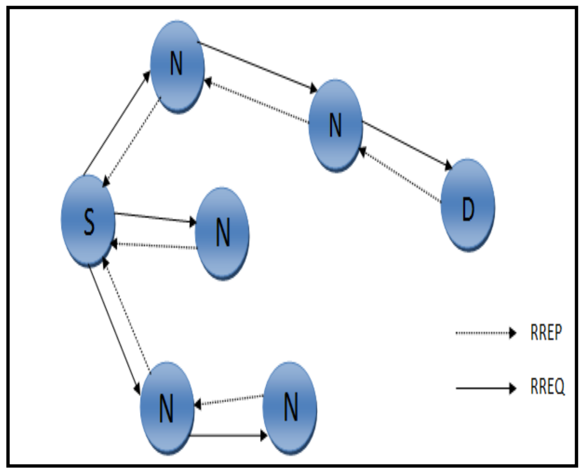

Figure-3 Traversal of control messages

9. REVIEW ON RELATED APPROACHES

Alagu & Meyyappan , 2011[4] analysed the different traffic schemes for handoff handling and call blocking attempts. As traffic in mobile cellular networks increases, Handoffs will become an increasingly important issue and as cell sizes shrink to accommodate an increasingly large demand of services, newer more efficient handoff schemes need to be used. In this paper the author analyses the various Handoff schemes for multiple traffic system.

Kirsal & Gemikonakli, 2000 [2] In this paper, wireless cellular systems of handoff schemes with channel failures and repairs are modelled. Product form, Markov reward model and exact Spectral expansion modelling approaches are discussed in detail and numerical results are provided for each of these approaches. Mobility issues such as velocity of MS are considered together with the availability issues. Also the performance measures, such as blocking probability and mean queue length are presented in order to illustrate the effects of failures, and accuracies of approximate methods.

Himanshu & Vatsa ,2011[16] stated that for better and smart data communication, a better handoff mechanism plays an important role in the handover process between the vehicular nodes during the vehicles are running on the road then mobile agent plays a important role in retrieving the information during the handoff process. For this authors proposed a cluster based VANET architecture which admit new node to new cluster with the help of Genetic Algorithm gives the priority to the calls and a better quality of information retrieval is proposed which retrieve information using the shadowing of information in the clusters of VANET which helps the user to use the internet and mobile services inside their vehicles.

Yogita [6] supposed if transferring message log and checkpoints with every handover, it can put extra overhead on network bandwidth and also increases transfer cost, thus here the author tried to restrict transfer of recovery information and allowed only when MN moves out of particular range.

Bing & Chun (2000)[17] proposed an analytic and simulation model study the performance of soft handoff. Their study shows that the handoff network response time, the mobility of the user and the overlay time significantly affect the performance of soft handoff. This study provides guidelines to determine the degree of the overlay among cells.

Parveen & Ruchi (2011)[18] have proposed an optimistic based message logging approach for cluster based ad hoc networks in which each MH in the cluster takes checkpoint independently. Also, each message that is delivered to MH in the cluster is routed through CH which avoids the overhead of message logging at MH. MH only carries minimum information and all the dependency tracking and mobility of MH can be properly traced by CH . The asynchronous checkpointing scheme relives the MH from any kind of coordination and they can take their checkpoints whenever they want.

Aggeliki & et.al(2009)[19] provided a comprehensive survey of the basic elements and the different types and phases of the handoff procedure. Particular interest has been given to the horizontal handoff execution phase by classifying the most recent handoff prioritization schemes into categories in the vertical handoff decision phase by presenting different decision algorithms.

Sapna et.al(2006)[20] presented an algorithm in which each MN maintains a counter which is incremented by 1 when MN performs a handoff to another cell. Once this counter becomes greater than a predefined value, a checkpoint is taken. This counter depends on the user's mobility rate, failure rate and log arrival rate. Each MN also maintains a set of MSS which stores MN's log after latest checkpoint. When a MN performs a handoff, a new MSS is added to this set if MN sends at least one message in the cell to the new MSS and if MSS has already not been added to the set. MSS logs messages before sending them to the destination. These messages are retrieved from MSS to recover a failure free state of MN after failure occurs. Once a new checkpoint is successfully taken by MN, set of MSS stored in MN is cleared and a message is sent to the MSS in the set to clear the log related to MN. Thus, storage overhead is reduced.

Shurman & et.al [23], the authors describe a protocol in which the source node verifies the authenticity of a node that initiates RREP by finding more than one route to the destination. When source node receives RREPs, if routes to destination shared hops, source node can recognize a safe route to destination.

Shantidev & Ian[25] develop a cross-layer handoff management protocol called CHMP, which estimates mobile's speed and predicts the handoff signaling delay of possible handoffs

10. MOVEMENT BASED ASYNCHRONOUS SCHEME

During the handoff procedure, that is, when a mobile node N_i moves from the old MSS to new MSS , as shown in the figure 3, Trace $_i$, which was maintained by old MSS get transferred to the new MSS. New MSS , then saves the Trace $_i$ record into its stable storage. Now when the new MSS saves a new checkpoint for the N_i , it puts the checkpoint sequence number in the $Trace_i$.cp_seq and its id into $Trace_i$.cp_loc and makes the $Trace_i$.log_set list empty, so that it can include only the MSSs which have saved the message logs after the latest checkpoint.

As a mobile node N_i moves from one MSS to another, the message logs of N_i becomes distributed over the stable storages at various MSSs it has visited. Now consider the situation that a failure has occurred at N_i and its latest checkpoint lies at MSS which is quite far away, then in this case, the cost of obtaining the checkpoint and the corresponding message log will be very high. Therefore a movement based scheme for recovery is proposed in this paper. Idea is that, the checkpoint and message logs need to be moved into a new MSS during the handoff only when the moving distance of the MSS to which mobile host is connected from the MSS carrying the latest checkpoint exceeds a certain threh hold value Tv. Each MSS maintains a distance table that include the distance between any other MSS and itself. Let us consider D $_{i,p,q}$ is the distance between the mobile support station S p in which h i is currently residing and the mobile support station MSS_q carrying the latest checkpoint. After each handoff, the new MSS, that is , MSS_q calculates the distance D $_{i,p,q}$ and perform normal handoff if D $_{i,p,q}$ < Tv. Only when D i,p,q > K , then the latest checkpoint and message logs are transferred to the new MSS i.e., MSS_q (Sapna & Yogita [6][20]).

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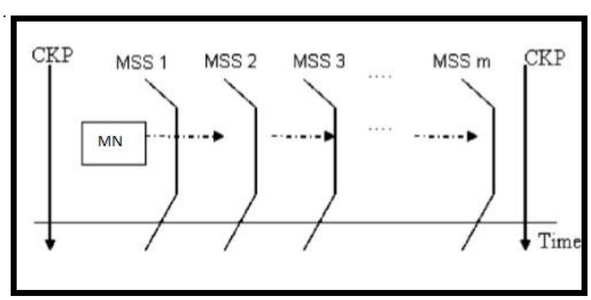

Figure-3 Movement Based scheme

11. HANDOFF DECISIONS

11.1 Network-Controlled Handoff

In this handoff protocol, the network makes a handoff decision based on the measurements of the MNs at a number of MSSs. In general, the handoff process (including data transmission, channel switching, and network switching) takes 100–200 ms. Information about the signal quality for all users is available at a single point in the network that facilitates appropriate resource allocation. Network-controlled handoff is used in first-generation analog systems such as AMPS (advanced mobile phone system), TACS (total access communication system), and NMT (advanced mobile phone system).

11.2 Mobile-Assisted Handoff

In this handoff process, the MS makes measurements and the network makes the decision. In the circuit-switched GSM (global system mobile), the BS controller (BSC) is in charge of the radio interface management. This mainly means allocation and release of radio channels and handoff management. The handoff time between handoff decision and execution in such a circuit-switched GSM is approximately 1 second.

11.3 Mobile-Controlled Handoff

In mobile-controlled handoff, each MN is completely in control of the handoff process. This type of handoff has a short reaction time (on the order of 0.1 second). MN measures the signal strengths from surrounding MSSs and interference levels on all channels. A handoff can be initiated if the signal strength of the serving MSS is lower than that of another MSS by a certain threshold value 'Tv.

12. CONCLUSION

There are various reasons that proposed handoff have many advantages as compared to the normal handoff. In this scheme mobile node (MN) leaves the handoff region before establishing a connection with the new MSS, resulting in a handoff failure, it will be connected to the network and AODV finds the new channel very quickly, which is nearer to the MN until it connected with new MSS and provide a smooth path which causes less overhead therefore, in this scenario handoff failure is minimum. In normal handoff failure, if scanning process is time consuming due to high traffic density and high overhead. The high traffic density increases the ratio of handoff failure. Thus with the help of proposed scheme by using AODV routing protocol in effective handoff region, handoff failures can be reduced to a great extent, also it overcomes the bandwidth problem, as this protocol has the capability to consume less bandwidth.

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